STATEMENT OF WORK

FOR

MEDIUM VOLTAGE DRIVE TO SERVICE 1750HP DYNAMOMETER MOTOR AT THE 36" VPWT

1. GENERAL REQUIREMENTS: This contract concerns provision of a new medium voltage AC drive system including, but not limited to, isolation transformer, variable frequency drive (VFD), input starter, power faction correction controller, and start up assistance, in accordance with this Specification and Attachments.

2. BACKGROUND: The new medium voltage drive is to be used to operate an existing forced air ventilated motor. The motor is part of the 36" variable pressure water tunnel (36VPWT) at the Naval Surface Warfare Center Carderock Division (NSWCCD) Hydrodynamic testing facilities. This motor is used to run experimental propellers in a closed circuit water tunnel. The motor is operated in both motoring and generating mode. This motor is part of a dynamometer drive system, which includes an existing variable frequency power supply (VFPS). The VFPS is to be removed and the new ac drive system to be installed in it place. The existing VFPS consists of a reversible Westinghouse two speed ac induction motor that is attached to an eddy current clutch that is it self attached to an ac synchronous generator. The existing VFPS system is located in the basement of building 16; the new VFD will be located in the same location. The existing VFPS system allows the speed of the induction motor to be adjusted over a speed range of 250 to 4600 rpm. Dynamometer shaft speeds above 4600rpm are achieved by coupling a gearbox between the drive motor and the shaft. Th gearbox provides a step up in speed of 2.174 to 1 to give speeds from 4600 rpm to 10,000 rpm. Limitation of the existing control scheme, necessitate the 250rpm lower limit, the new VFD drive is required to operate the motor at near zero speed as specified below.

   2.1 Existing Documentation and Nameplate Data:

      2.1.1 Floor plan of the room the VFD system will be installed in. New VFD drive system shall be delivered in sections that can fit through roof hatch shown on attachment 1.

3. SUMMARY OF REQUIREMENTS:

   3.1 System Supply Voltage: 2400VAC (+/-10), 60Hz

   3.2 VFD Auxiliary 3 Phase Power: 480vac (+/-10), 60Hz.

   3.3 Load/Application Requirements: Speed range of 0-3600rpm with a constant torque, speed range 3600-4600rpm constant horsepower.

   3.4 VFD Continuous output current rating: Rated motor current.

   3.5 Digital Inputs: Minimum of 6, two to be used for remote start/stop of drive.

   3.6 Digital Output: Minimum of 9 outputs pre-configured for VFD system status as indicated in paragraphs 4.23.

   3.7 Hardwire input: External normally open emergency stop relay contact. Contact open indicates external fault.

   3.8 Motor data

      3.8.1 Motor Data: Westinghouse corporation S.O. 50-P-839, 1750 hp, type CS induction, 60°C rise, Class B insulation, 2300V, 364amp, 3 phase, 60 Cycles, 2 poles, 3573 RPM. Maximum speed 4600 RPM, Rotation either direction up to 4600 RPM with forced lubrication system, direct connected tachometer, ventilating blower and motor.

      3.8.2 VFD shall be capable of operating the motor in the forward & reverse directions, in motoring mode, regenerative mode for overhauling loads and quick de-acceleration.

   3.9 Speed range: 0-4600rpm without gearbox and 0-10,000 rpm with gearbox. Gearbox is not presently used, but drive must be capable of scaling output rpm if gearbox were used. Operation at speeds less than 10rpm are not mandatory.

   3.10 Speed Regulation: As listed in paragraph 4.6.3.

   3.11 VFD Output: Sine wave with total harmonic content of not more than that list in paragraph 4.7.1.

   3.12 VFD Cooling Method: Air-cooled with provision for ducting exhausted air.

   3.13 Bar type metering on LCD display for output of speed, voltage, current, load.

   3.14 Analog Input: 4-20ma input signal for speed reference input.

   3.15 Analog Outputs: Total of not less than 3, rated (4-20ma) or (-/+10volt) outputs programmable for speed, voltage, current, load (KW) and torque. Speed reference output shall be 4-20ma.

   3.16 Design Standard: UL 347A

   3.17 Testing: Standard

   3.18 Environmental Conditions: As detailed in paragraph 4.4.

3.19 Auxiliary Equipment: Input starter w/vacuum contactor, and fused isolating switch. Input isolation transformer.

3.20 Communication Options: ControlNet adapter or DeviceNet adapter.

3.21 Services: VFD startup assistance.

3.22 Standards: The VFD system shall be designed and constructed to Underwriters Laboratory (UL) standards.

3.23 Available short circuit amperes at the point of connection of VFD system is 32.4Ka symmetrical and 41.5Ka asymmetrical.

4. PRODUCTS: This contract shall provide a medium voltage drive system components rated as listed below, for use in the environment specified below.

4.1 The VFD shall be factory pre-wired, assembled and tested as a complete package by the VFD supplier. Customer specific drive, motor, and application data shall be pre-loaded into the operator interface and tested prior to shipment

4.2 The VFD supplier shall demonstrate at least ten years experience in manufacturing VFDs at medium voltage for similar applications at the desired voltage and power ratings. A user list, complete with contact names and telephone numbers, shall be furnished upon request.

4.3 Source and control voltage:

4.3.1 The VFD shall accept nominal plant power as listed in paragraph 3.

4.3.2 Low voltage, 3 phase auxiliary power shall be as listed in paragraph 3, to power the VFD cooling system and VFD control circuits.

4.4 Environmental conditions

4.4.1 The VFD shall operate in an ambient temperature range of 0°C to 40°C (32°F to 104°F) with a relative humidity of up to 95% (non-condensing).

4.4.2 The equipment shall be capable of being stored in an environment with an ambient temperature range of -20°C to 65°C (-4°F to 149°F).

4.4.3 The equipment shall operate at altitudes from 0 to 1000 m (3,300 ft.) above sea level, without de-rating.

4.5 Codes and Standards

4.5.1 The VFD & controllers equipment shall comply with the applicable requirements of the latest standards published by the following organizations:

- American National Standards Institute (ANSI) "Instrument Transformers C57.13"
- Institute of Electrical & Electronic Engineers (IEEE)
- National Electrical Code (NEC)
- Electrical & Electronic Manufacturers Assoc. of Canada (EEMAC)
- Occupational Safety & Health Act (OSHA)
- Guide for Harmonic Control and Reactive Compensation of Static Power Converters (IEEE 519-1992)
- National Electrical Manufacturers Association (NEMA) "Medium Voltage Controllers Rated 1501 to 7200V AC ICS 3-2 (formerly ICS 2-324)"
- Underwriters Laboratories, Inc. (UL) (High Voltage Industrial Control Equipment 347)
- UL 347A Medium Voltage Power Conversion Equipment Preliminary Standard

4.5.2 Rectifier duty drive isolation transformers shall comply with the following standards:

- IEEE C57.12.01-1989, IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers.
- ANSI C57.12.10-1988, American National Standard for Transformers – 230 KV and Below 833/948 through 8333/10417 KVA, Single-Phase, and 750/862 Through 60000/80000 KVA with load TAP Changing – Safety Requirements.
- ANSI C57.12.51-1981, American National Standard Requirements for Ventilated Dry-Type Power Transformers, 501 KVA and Larger, Three-Phase with High-Voltage 601 to 34500 volts, Low-Voltage 208Y/120 to 4160 Volts.
- ANSI C57.12.70-1978, American National Standard Terminal Markings and Connections for Distribution and Power Transformers.
- IEEE C57.12.91-1995, IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
- IEEE C57.18.10-1998, IEEE Standard Practices and Requirements for Semiconductor Power Rectifier Transformers.

- IEEE C57.124-1991, IEEE Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers.
- IEC 60076-1, Power Transformers: General.
- IEC 60076-2, Power Transformers: Temperature rise.
- IEC 60076-3, Power Transformers: Insulation levels and dielectric tests, Ammendment No.1.
- IEC 60076-3-1, Power Transformers: Insulation levels and dielectric tests. External clearances in air.
- IEC 60076-4, Power Transformers: Tappings and Connections.
- IEC 60076-5, Power Transformers: Ability to withstand short circuit

4.6 VFD performance requirements

4.6.1 The VFD shall produce a variable voltage and variable frequency output to provide continuous operation over the application speed range. The VFD shall be capable of operating with the output short circuited at full current or with the output open circuited at rated voltage.

4.6.2 VFD shall be capable of operating existing standard AC squirrel cage motor over the speed range specified in paragraph 3. In addition the VFD minimum output frequency shall be less than 1Hz.

4.6.3 Standard AC squirrel cage induction motor The drive system shall provide controlled speed over the range specified. Speed accuracy within this range, expressed as a percent of top speed, shall be within 0.1% of base speed without encoder or pulse tachometer feedback and 0.01% with encoder or pulse tachometer feedback.

4.6.4 The VFD shall have a "normal duty" rating of 100% continuous current listed in paragraph 3 with a short-time duty rating of 150% overload for one minute, once every 10 minutes. The VFD shall be capable of 100% breakaway torque without tachometer feedback. Breakaway torque with tachometer feedback shall be 150%. Regenerative braking capability shall be mandatory.

4.6.5 The VFD shall utilize sensorless direct vector control or full vector control, with pulse tachometer feedback, for optimum performance. Motor will be operated with encoder under normal conditions.

4.7 Motor compatibility

4.7.1 The VFD shall provide near sinusoidal voltage and current waveforms to the motor at all speeds and loads. Voltage distortion shall not exceed 5% and current distortion shall not exceed 3% to the utility line. Individual current harmonics shall not exceed the requirements of IEEE 519. Output current THD shall be less than 5%. Standard induction motors shall not require de-rating or upgraded turn-to-turn insulation and shall not require additional service factor. The motor insulation system shall not be compromised thermally due to dv/dt stress. Dv/dt at the motor terminals (line-to-line) shall be limited to 10 volts per microsecond. If dv/dt at the motor terminals (line-to-line) exceeds 10 volts per microsecond, the vendor must state the actual value in the attached data sheets and include steps taken to guarantee the long-term life of the motor insulation system.

4.7.2 The motor insulation system shall not be compromised due to excessive peak voltage of the output waveform. Motor peak line-to-line output voltage shall be limited to the 3394Vpk. If the motor peak line-to-line output voltages exceed the values, the vendor shall clearly state the actual value with the proposal and in the attached data sheets.

4.7.3 The VFD shall provide stable operation of the motor without compromising the motor insulation system, regardless of motor cable distance. The vendor shall clearly state the limitations in motor cable distance with the proposal. If an output filter is required to mitigate reflected waves, or to meet any special requirements of the application, it must be integral to the VFD controller.

4.7.4 If output filters are used in the VFD, a selective harmonic elimination (SHE) switching technique must be available to eliminate a potential harmonic resonance in the operating speed range.

4.7.5 VFD induced torque pulsation's to the output shaft of the mechanical system shall be less than 1% to minimize the possibility of exciting a resonance.

4.8 Line side harmonics

4.8.1 VFDs shall comply with the latest edition of IEEE 519 Harmonic Guidelines.

4.8.2 The following VFD rectifier solutions are acceptable:

4.8.2.1 The transformer shall contain three-phase secondary windings that provide the proper phase shifting to feed 18-pulse or 24 pulse rectifier.

4.8.2.2 Preference shall be given to drive systems that meet IEEE 519 harmonic guidelines with the lowest possible design complexity. The VFD supplier shall detail the number of main power components supplied in the VFD and number of secondary windings on the isolation transformer.

4.8.2.3 The VFD shall meet local requirements for telephone interference restrictions.

4.9 VFD system efficiency shall be a minimum of 96% at 100% speed & 100% load. System efficiency shall include VFD, input transformer or line reactor, harmonic filter (if applicable) power factor correction unit (if applicable), and output filter (if applicable). Control power supplies, control circuits, cooling fans or pumps, shall be included in all loss calculations.

4.10 Maximum audible noise from the VFD or associated VFD system shall comply with OSHA standard 3074, Hearing Conservation, which limits noise level to 85 dB(A). The VFD system shall comply with the OSHA standard at a distance of one meter from the front of the equipment (with doors closed at any speed or load condition). VFD systems with audible noise in excess of this limit must be provided with sufficient noise abatement treatment to reduce the sound pressure level below 85 dB(A).

4.11 The VFD shall be capable of maintaining a minimum true power factor (Displacement P.F. X Distortion P.F.) of .98 from 30-100% power. If the VFD vendor cannot meet the true power factor requirement, then a power factor correction unit shall be quoted as an option. The true power factor that can be met (with and without power factor correction unit) shall be stated clearly in the proposal.

4.12 Reliability

4.12.1 The VFD system shall be designed for a minimum availability of 99.9%.

4.12.2 The VFD system shall be designed for a Mean Time Between Failures (MTBF) of 100,000 hours.

4.13 The VFD system shall be designed for a minimum life expectancy of 20 years.

4.14 In order to optimize reliability and minimize complexity, inverter power switch component count shall be minimized by utilizing high peak inverse voltage (PIV) rated devices. Preference will be given to designs exhibiting the lowest overall power component count. The VFD shall have a control power monitoring system that monitors all power supply voltages and signals.

4.15 Diagnostics

4.15.1 Fiber optic interface boards shall be used to provide gating and diagnostic feedback signals for power semiconductor devices. The diagnostic feedback system shall allow constant control of the device as well as constant monitoring of device health and temperature feedback.

4.15.2 High-speed digital control systems shall continuously monitor all hardware and software faults including sensing of all power circuit voltage and currents as well as any internal equipment faults.

4.15.3 Power switch device diagnostics shall detect and protect against device short, over or under gate voltage, loss of gating, loss of diagnostic feedback, heat sink temperature feedback as well as overload monitoring and protection.

4.15.4 The VFD shall have provisions for a optional modem that provides remote diagnostic capability and interaction with the drive for factory based troubleshooting. Firmware upgrades shall be available via the Internet.

4.16 The VFD shall be capable of riding through a loss of power of 5 cycles.

4.17 The VFD shall be capable of automatically restarting in the event of a momentary loss of power, or a clearing of a drive trip.

4.18 VFD system shall be capable of operating with voltage sag of 30% on the input power line.

4.19 The VFD shall be capable of restarting and taking control of a motor attached to a spinning load in the forward or reverse direction.

4.20 The VFD shall have the following minimum drive protection features:

At Input Source Side:

1. Under voltage (adjustable)
2. Over voltage (adjustable)
3. Instantaneous over current (adjustable)
4. Ground fault (adjustable)
5. Overload (adjustable)

On System Level:

1. Gate driver power supply under voltage
2. Control power over / under voltage and signals
3. Over temperature protection

At Output Motor Load Side:

1. Short circuit protection (instantaneous over current)
2. Overload (delayed over current)
3. Over voltage (adjustable)

4. Motor over speed (adjustable)

4.21 Motor Protection

a) Electronic motor overload protection shall be supplied as standard.

b) A motor stall protective function will be supplied on all units. The amount of time the drive will be allowed to run at current limit under minimum speed shall be adjustable.

4.22 Operator interface and communications: The VFD shall have a user-friendly operator interface terminal with the features listed below.

4.22.1 Large LCD display screens (minimum 16 line – 40 characters) that are easy to read and provide 'at a glance' indication of drive operating status

4.22.2 User configurable bar type LCD metering for motor speed, load, torque, and voltage

4.22.3 Elapsed time indication

4.22.4 Extensive diagnostic functions that provide separate fault and warning queues in non-volatile memory that retain information under all conditions

4.22.5 On-line help that provides enhanced fault text messages

4.22.6 Trend buffers for at least 8 variables that allow one-shot or multi-shot trending

4.22.7 Multi-level password access to ensure that only qualified personnel have access to critical parameters but still allow easy access to other levels of personnel.

4.22.8 Extended use of plain language messages to eliminate need to look up error codes or decipher the meaning of error messages

4.22.9 Start-up wizard, including auto tuning, that is interactive and user-friendly

4.22.10 The VFD shall be provided with digital communication capability to allow direct control and status communication with a PLC, SCADA or other control system as indicated in paragraph 3.

4.23 Inputs and Outputs

4.23.1 Isolated digital inputs and isolated digital outputs shall be available as standard on the drive, rated from 12V to 260V AC or DC.

4.23.2 Digital Outputs shall be pre-configured to indicated VFD status:

- Stopped
- Running
- Faulted
- Ready
- Input contactor open
- Input contactor closed

4.23.3 Isolated analog signal interfaces (minimum of four) shall be configurable for:

- Speed reference input (4-20 mA input signal).
- *Speed output (4-20 mA output signal).
- *Voltage output (4-20 mA or (+/-10) volt output signal).

- *Current output (4-20 mA or (+/-10) volt output signal).
- *Load (kW) output (4-20 mA or (+/-10) volt output signal).
- *Torque output (4-20 mA or (+/-10 output signal).

* 3 output shall be configurable amount the 5 possible output list in table.

4.23.4 Windows based application software shall be provided to monitor and edit drive parameters, upload and save parameters to a file, download parameters to the drive, print parameters, and view and clear faults/alarms in the drive.

4.23.5 The VFD shall be controlled locally via start/stop pushbuttons, emergency stop push button, local/remote selector switch, and speed reference potentiometer.

4.24 Service and maintenance

4.24.1 Failed power switch components shall be replaceable without removal of the entire power module. Special tools or force measuring transducers shall not be required. Failed power switch components shall be replaceable in less than 15 minutes.

4.24.2 Converter power modules shall be repairable in 15 minutes or less. If entire power module is replaced, vendor to specify mean time to repair failed power modules.

4.25 Air cooling system

4.25.1 The VFD system shall be air-cooled.

4.25.2 Air-cooled VFDs shall be provided with a mixed flow cooling fan mounted integral to the VFD enclosure. The VFD shall include airflow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If a fan fails, the system must generate alarm indication of the fan failure. Vane type airflow switches are not acceptable.

4.25.3 Provision shall be made for ducting VFD exhaust air outside the control room.

4.26 Enclosure rating / construction

4.26.1 VFD enclosures for VFDs shall be NEMA 1G (IEC IP21). Door vents shall consist of louver-panel assemblies that can be removed from the front in order to replace air filters. Safety screens shall be located behind each louver panel. Cabinets and doors shall be fabricated using minimum 12 gauge (2.64 mm thick) steel for sturdy construction. All doors shall be gasketed to provide environmental protection and secure fits.

4.26.2 Door latches shall be heavy-duty ¼-turn type units, which are operated with an Allen wrench. The converter cabinet door and cabling cabinet door shall be interlocked with up-stream isolators or breakers with a key lock. Interlocking shall be fully coordinated to prevent access to all medium voltage compartments.

4.26.3 The VFD shall be designed for front access to all components. Equipment that requires rear or side access will not be accepted.

4.27 Structure finish: Standard, all VFD exterior and interior metal parts (except for the power cell back plates and low voltage panel) shall be painted Manufacturer's standard color. All metal back plates in the power cell and low voltage compartments shall be painted high gloss white for high visibility.

4.27.1 All unpainted steel parts shall be plated with a zinc plate/bronze chromate process for corrosion resistance.

4.28 Cabling:

4.28.1 The VFD shall contain a power cable termination assembly designed for easy termination and access to line and load cables. The termination assembly cabinet shall allow for top and bottom entry and exit of line and load cables.

4.28.2 A low voltage wire way shall be provided at the top front of the VFD and shall be available with a removable cover.

4.28.3 All power and control terminations and termination strips shall be identified in accordance with all schematics and wiring diagrams.

4.28.4 Low voltage control wire shall be TEW tinned, 600 volt AC rated.

4.28.5 All VFD internal power connections shall be made with tin plated copper bus or 8 kV (minimum) insulated power cable.

4.29 Rectifier duty transformers:

4.29.1 The VFD supplier shall provide impedance device in the form of a indoor, dry type rectifier duty transformer

4.29.2 Indoor, Dry Type Transformers: The following minimum standard features will be provided:

1. One (1) normally closed auto reset thermal switch per coil, wired in series to a terminal strip.
2. 220 °C insulation class, 150°C rise, AA Cooling Class.
3. Fully insulated from phase to ground and neutral to ground.
4. Fully insulated between secondary windings.
5. Lifting eyes on core and coil assembly - complete unit.
6. Removable jacking and lifting provisions on enclosure base assembly - complete unit.
7. Diagrammatic nameplate.
8. Base suitable for jacking, pulling and rolling.
9. Type 1 ventilated indoor enclosure, extra wide for bottom or top cable entry/exit (If not integral to VFD).
10. The transformer shall be designed for continuous operation at its base kVA rating (natural cooling) without exceeding the temperature rise. The short time rating shall be adequately designed to deliver the power demanded by the drive without loss of insulation life.

4.29.3 Output transformers or step-up transformers are not acceptable for use with AC Variable Frequency Drives.

4.30 Auxiliary equipment: Input Disconnecting Means: For power circuit protection and isolation of the VFD from the main supply, an input starter (sized for motor current) shall be provided with the following minimum design criteria:

4.30.1 The structure shall consist of a metal enclosed free-standing dead-front vertical steel assembly. It shall contain:

1. Tin-plated, copper, horizontal power bus
2. A copper ground bus
3. A main non-load-break isolating switch
4. A vacuum break contactor
5. A low voltage contactor control panel

4.30.2 The power cell shall be designed to accept bolt-on or clip-on current limiting fuses for class E2 operation.

4.30.3 The structure will be divided into isolated compartments as follows:

1. Main power bus and ground bus compartment
2. Power cell compartment
3. Low voltage compartment
4. Low voltage wireway across the roof of the structure

4.30.4 Each structure shall also have a non-removable base channel and removable lifting angles for ease of installation.

4.30.5 Main Power Bus

1. The main horizontal power bus shall made of tin-plated copper.
2. Access shall be provided to the bus compartment from the front or the rear of the structure to allow for installation and regular maintenance of the power and ground bus splice connections.
3. The horizontal buswork, the cabling/bus from the main power cell shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347 (paragraph 30).

4.30.6 Bus Bracing

1. The horizontal/vertical buswork and the cabling/bus in the main power cell(s) shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347.
2. Buswork and cabling shall be braced to withstand the let-through energy allowed by the largest fuse a short circuit fault.

4.30.7 Ground Bus: A continuous copper ground bus shall be provided along the entire length of the controller line-up. A mechanical lug for #8 to #1/0 AWG or #6 to 250 MCM cable shall be supplied at the incoming end of the line-up. The ground bus shall be bare copper.

4.30.8 Vacuum Contactor Specifications

1. The contactor shall be electrically (magnetically) held medium voltage contactor.

2. The contactor shall have visual contact wear indicators. No special tools are required for checking contact wear.
3. Vacuum bottle and coil maintenance shall not require removal of the vacuum contactor.

4.30.9 Vacuum input contactor shall be fixed mounted inside the power cell. Fixed mounting provides solid, continuous contact while lowering maintenance requirements considerably. The contactor shall be interlocked with the non-load-break isolating switch, both electrically and mechanically, which shall provide the following safety features:

1. Prevent the isolating switch from being opened or closed when the contactor is in the closed position.
2. Prevent the opening of the medium voltage door when the isolating switch is in the closed position.
3. Prevent the closing of the isolating switch when the medium voltage door of the controller is open.
4. Remove control power from the control power transformer (CPT), power transformers (PTs) or external power source to the control circuit when the isolation switch and contactor are in the open position.

4.31 achometer Requirements: Provide encoder to match VFD and speed requirements of paragraph 3, Encoder will be directly connected shaft of motor.

4.32 Warning plates, isolation barriers, and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.

1. Warning labels and nameplates must be present and in their specified positions to advise personnel of possible hazards.
2. Isolation barriers must be in place within the cabinet. Such barriers protect personnel from touching live medium voltage components in an area that otherwise does not have power supplied to it.
3. Operation of isolation switch handle and door interlocks must be verified. The interlocking prevents the opening of any medium voltage door on a medium voltage cabinet when the isolation switch handle has been moved to the full ON position.

5.0 OBLIGATIONS OF SUPPLIER: Any exceptions or deviations shall be defined in writing at the time of bid.

6.0 SPARE PARTS: Recommended spare parts list and prices shall be supplied with the bid. Also, the address of the Supplier's closest parts stocking location to the User shall be provided.

7.0 SUBMITTALS: The Supplier shall furnish two (2) copies of the following documents with the quotation:

7.1 Descriptive bulletins to include ratings, protection, controls, diagnostics, and operation.

7.2 A system harmonic statement assuring compliance with IEEE 519 at the drive terminals.

7.3 Heat loss data for each typical unit.

7.4 Drive system efficiency, including the effects of transformers, fans and other devices.

7.5 Outline drawings with weights and dimensions for all components required to meet the specification.

7.6 Warranty details.

7.7 The Manufacturer shall submit drawings and data of the type and quantity shown in the table below.

[A] With Bid	[B] For Review	[C] Final Certified	[D] As Built	DESCRIPTION
	X	X	X	Bill of Material
	X	X	X	Outline drawings showing all dimensions, weights; and the final assembled configuration.
	X	X	X	Single-line, 3-line, and control schematic diagrams with connection diagrams for all electrical equipment supplied.
X				Harmonic statement
			X	Installation, Operation, Programming, and Maintenance Manual(s)
		X		Certified Test Reports
	X		X	Recommended priced spare parts list

[A] Bidder shall furnish these documents with proposal.
[B] Manufacturer shall furnish these documents for Buyer's review and authorization to proceed before fabrication.
[C] Manufacturer shall furnish these documents as part of the final certified document submittal.
[D] Final As-Built drawings provided within 30 days following shipment.

7.8 Final As-Build drawing, manuals and test data shall be provided in electronic form, as well as hard copies. Electronic form shall be DXF, AutoCAD or PDF.

8.0 QUALITY ASSURANCE

8.1 All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system. This system must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.

8.2 All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

8.3 All sub-assemblies shall be inspected and/or tested for conformance to Supplier's engineering and quality assurance specifications.

8.4 The product must meet all applicable engineering and workmanship standards and specifications. All components shall be verified against engineering documentation to be present and correctly installed.

8.5 All bus and bus connections shall be checked for proper clearance, creepage, phasing, and torque.

9.0 FACTORY TESTING

9.1 The following tests shall be carried out in accordance with applicable requirements and/or specifications of Underwriters Laboratories (UL), and National Electrical Manufacturers Association (NEMA).

9.2 Functional checks shall be performed wherever possible; otherwise, inspection and continuity checks shall be made.

9.3 A "HI-POT" dielectric withstand test shall be performed on all bus work and cables from phase-to-phase and phase-to-ground (except solid-state components, low voltage controls and instrument transformers). The voltage level used for this test depends on the product's nominal AC voltage.

9.4 Component devices shall be functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.

9.5 Instruments, meters, protective devices and associated controls shall be functionally tested by applying the specified control signals, current and/or voltages.

9.6 Medium Voltage Drives shall be inspected for the following:

- Control Power Failure Test
- Rectifier Gating Checks
- Inverter Gating Checks
- Line Converter Tests
- Machine Converter Tests
- Load Tests

  – Drives shall be accelerated to the test motor's nominal frequency, under load, decelerated to 10 Hz, then accelerated back to test motor's nominal frequency, with a ramp time of approximately ten seconds. This cycle shall be repeated continuously for up to one hour.

  – Drives shall be tested under load at the test motor's nominal frequency.

10. ON SITE START-UP SERVICES: Contractor shall provide up to three days of start up assistance. Start-up will be performed at the NWSCCD. The Supplier shall provide the following:

- A pre-installation meeting with the User to review:
  – The start-up plan
  – The start-up schedule

– The drive's installation requirements
- Inspect the drive's mechanical and electrical devices enclosed
- Perform a tug test on all internal connections within the drive and verify wiring.
- Verify critical mechanical connections for proper torque requirements.
- Verify and adjust mechanical interlocks for permanent location.
- Confirm all sectional wiring is connected properly.
- Re-verify control wiring from any external control devices.
- Set up all drive internal power supplies and thyristor control circuits.
- Verification of proper phasing from isolation transformer to drive.
- Confirm cabling of drive to motor, isolation transformer and line feed.
- Perform Megger test.
- Apply medium voltage to the drive and perform operational checks.
- Bump motor and tune drive to the system attributes.

10.1 The motor shall be run with water tunnel operational setting. Tunnel shall be filled with water. The impeller motor shall be run to create water flow in the tunnel. The dynamometer motor shaft will have the dumpy hub or experimental propeller attached to shaft. Several propellers will be needed to test new VFD through entire speed range and loads encounter during normal testing. During VFD testing speed regulation shall be mounted to verify it remains in range set by this specification. Speed Testing of dynamometer motor and VFD shall process as follow:

10.1.1 VFD drive shall be set to remote control, as commands will be given from tunnel control system.

10.1.2 Verify VFD starts and stops on commands given by control system.

10.1.3 Verify VFD stops if external emergency stop relay drops out.

10.1.4 Verify VFD runs at speed set by 4-20mamp signal sent from tunnel control system and set speed is maintained within regulation limits set by this specification, with the loads given in paragraph 10.3.5.

10.1.5 The VFD shall be tested under up to 4 load conditions.

1. Dumpy hub on shafts of dynamometer motor, i.e. no load on shaft. VFD drive shall be run through full speed range.
2. High speed propeller on the shaft of the dynamometer motor. VFD drive shall be run through full speed range.
3. Medium speed propeller shall be mounted on the shaft. VFD drive shall be run through speed range restricted by propeller to less than 3000rpm.
4. Low speed propeller shall be mounted on shaft of dynamometer shaft. VFD drive shall be run through a speed range restricted by propeller to less than 1500rpm.

11.0 PAYMENT SCHEDULE: This contract is intended to be a fixed price commercial buy, the contractor may render partial invoices and require progressive payments according to the following payment schedule:

11.1 Upon award of contract, the contractor may submit an invoice for material costs.

11.2 Upon government approval of design review of controller system, the contractor may submit an invoice for their design efforts.

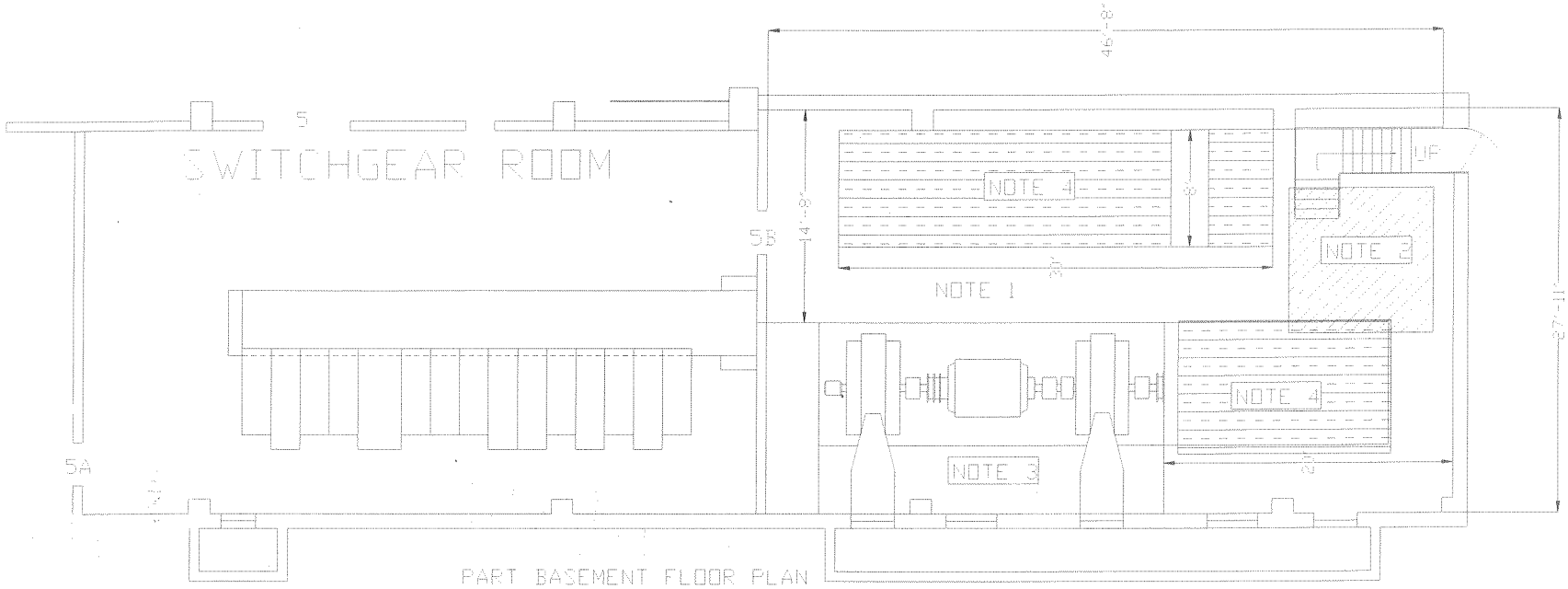
11.3 Upon government reception of contractor equipment delivery, the contractor may submit an invoice for the construction cost of the controller.

11.4 Upon installation and final government acceptance of the controller system, the contractor may submit a final invoice for the completion of the project.

12.0 SHIPPING: Unless specified otherwise, preparation for shipment shall be in accordance with Manufacturer's standards. Loose equipment shall be appropriately packaged and secured for shipment inside the enclosure or shipping container. These items shall be properly tagged for easy identification.

13.0 WARRANTY: Warranty shall extend for a minimum of 12 months after startup, 18 months after shipment. Warranty shall include parts, labor, travel time and expenses. Seller must state clearly the details of warranty offered with his equipment.

END OF SPECIFCATION



NO SCALE

NOTES:

1. BASEMENT ROOM WERE THE NEW VFD DRIVE SYSTEM IS TO BE PLACED. FLOOR TO CEILING HEIGHT IS 13FT, ROOM DIMENSIONS ARE AS SHOWN. ADJACENT SWITCHGEAR ROOM WILL BE 2.4KV & 480VAC POWER SOURCE FOR VFD DRIVE SYSTEM.

2. ROOF HATCH, NEW VFD DRIVE SYSTEM SHALL BE BROKEN DOWN INTO SECTIONS THAT CAN FIT THROUGH THIS HATCH. HATCH IS THE ONLY EQUIPMENT ACCESS TO ROOM.

3. EXISTING M/G SET TO REMAIN. ALL OTHER EQUIPMENT IN ROOM CAN BE RELOCATED TO MAKE ROOM FOR NEW VFD DRIVE.

4. PROPOSED LOCATIONs FOR NEW VFD DRIVE SYSTEM. DIMENSIONS ARE AS SHOWN.

ATTACHMENT 1

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